OLDMAN BOILER WORKS,
BOILER SHOP
32 Illinois Street
Buffalo
Erie County
New York

HAER No. NY-272-A

HAER
NY
15-BUF
41A-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
Northeast Region
Philadelphia Support Office
U.S. Custom House
200 Chestnut Street
Philadelphia, P.A. 19106

HAER
NY
15-BUF
41A-

HISTORICAL AMERICAN ENGINEERING RECORD

OLDMAN BOILER WORKS, BOILER SHOP HAER No. NY-272-A

Location:	32 Illinois Street Buffalo, Erie County New York UTM: 17.673540.4748850 Quad: Buffalo, SE, New York
Date of Construction:	1907
Architect:	W.H. Zawadzki
Present Owner:	Edward Berger dba Oldman Boiler Works
Present Use:	Boiler repair and steel fabrication
Significance:	The boiler shop is the oldest extant building on the site. It represents a common type of construction used in single-story plants. This class of industrial architecture followed general period trends toward more fire-resistant and spatially-efficient forms while differing in detail from multi-story factory designs. The boiler shop contains several significant machines, including pyramid plate bending rolls.
Project Information:	This building will be demolished for construction of the Crossroads Arena. As a mitigative measure documentation to HAER standards was stipulated as part of negotiations among several parties, including the NYS Urban Development Corporation and the NYS Office of Parks, Recreation and Historic Preservation.

Thomas Leary and Elizabeth Sholes
Industrial Research Associates
816 Ashland Avenue
Buffalo, New York 14222

Description of Building

The boiler shop is a high single-story building designed on a three-bay plan. It occupies a lot whose frontage on Illinois Street measures 75', and the property extends west toward Indiana street a distance of 100'. The higher central aisle is flanked by lower side bays on either side. A clerestory monitor extends the full length of the building, providing natural lighting for the work spaces below.[1]

Exterior walls are of brick-pier construction. The masonry has been painted blue. The east elevation is divided into three bays; the two central piers framing the main bay presumably correspond with the loads transmitted through the walls from the interior girders that carry overhead cranes. The north elevation is divided into eight bays, six of which are pierced by large rectangular windows. The piers of the north elevation carry the load transmitted by the interior steel beams supporting the roof of the north bay.

Windows on the east and north elevations have smooth-faced rectangular stone sills and lintels of varying proportions. Only the two upper windows in the north bay of the east elevation appear to have retained their original 4-over-4 double-hung sashes. The north elevation windows have steel sashes; these apertures have been covered with translucent material. A rolling metal shutter door occupies the lower portion of the central bay on the east elevation. There is corbelling below the eaves on the north elevation and below the cornice of the east elevation. Roofing materials appear to be asphalt shingling. Several sheet metal ventilators jut up from the roof over the main bay.

The south elevation of the boiler shop is not visible due to the subsequent construction of the office/machine shop in 1918. The window openings of the south wall have been filled. The west wall of the boiler shop was removed at the time the fabricating shop was added in 1951 in order to allow overhead cranes to travel continuously through the main bays of both buildings which now function as a single unit.

The floor of the 1907 boiler shop is concrete. The interior framing of the main bay consists of a double row of steel columns that support the crane girders and the roof trusses. These columns are rolled H-sections with angles riveted into the webs for additional stiffening. Brackets are riveted to the columns and the crane girders rest upon these projecting braces. A pair of electric overhead cranes can over the rails on these girders which extend west into the main bay of the 1951 fabricating shop. These cranes each carry 5-ton hoists. The east crane is a Shepard model; the west crane was furnished by Pawling & Harnischfeger. Both cranes are operated from the shop floor, and both run on 25-cycle current delivered through the three wires running along the inside of the crane girders.

Above the crane girders the tops of the main bay columns are connected longitudinally by a single pair of angles joined by lattice webbing. There is diagonal bracing between these angle members and the columns. Midway between the tops of the columns and perpendicular to the longitudinal angle pairs are additional paired angles, riveted back-to-back and also connected with lattice webbing. The location of these perpendicular paired angles corresponds with the steel I-beams that slope down to support the roof in the north and south bays.

The various members of the roof trusses have riveted connections, and the truss itself appears to be a modified Warren design. There are three roof trusses in all. A series of diagonal tension rods connect the roof trusses, presumably functioning as wind bracing. The load carried by the roof trusses consists of longitudinal steel ridges and purlins, wooden rafters, and plank roofing. Where the west wall of the 1907 building has been removed at the juncture with the 1951 fabricating shop a steel kingpost truss has been inserted to carry a portion of the roof load.

Composite steel and frame materials are also evident in the roof construction of the north and south bays. Transverse I-beams bearing on the brick wall piers support longitudinal wooden members having cross bracing at some points. Some transverse beams are connected by diagonal steel tension rods. The roof is plank.

The 1907 boiler shop is 96'10 1/2" in overall length, measured between the interior of the east and former west walls. The main bay is 32' wide. Each of the side bays is 19' in width. The height of the main bay is 23'6" to the top of the crane girders and 28'6" to the lower chord of the roof trusses. It is 19' to the roof in the side bays at the eaves.[2]

Description of Machinery

The most significant pieces of equipment in the boiler shop, and indeed in the entire Oldman complex, are the two sets of plate bending rolls located in the south bay. These rolls are arranged in what was known as the "pyramid" style: a larger upper roller situated above and midway between a pair of smaller rollers. Only the lower rollers are driven, and these are fixed in position. The upper roller is adjustable up or down, thus regulating the degree of curvature imparted to the plate as it is passed between the rolls. As the upper roll is brought closer to the lower rolls, the diameter of the circle into which a plate can be rolled becomes smaller. A shaft carrying a clutch and running parallel to the rolls' axis at floor level furnishes the power for adjusting the position of the upper roll through bevel gearing in the roll housings. The housing opposite the motor can be opened to permit removal of a plate that has been rolled into a complete circle.[3]

At the eastern end of the south bay, the large rolls are capable of bending a steel plate 3" thick; the rolls themselves are 11'7" long. The length of the rolls is unusual, suggesting that they may have been custom made. The upper roll is approximately 18" in diameter, the lower rolls approximately 16". Power is transmitted to the lower rolls from a 30 hp @ 750 rpm Westinghouse ES motor through a series of speed-reducing devices that include a General Electric controller and an arrangement of spur-and-pinion gears. Plates are handled with the aid of two chain hoists. A jib crane carries a trolley manufactured by the Chisholm-Moore Hoist Co. of Tonawanda, New York. The original capacity of this trolley was 2 tons, but the present "Cyclone" hoist is rated at 1 ton. The second chain hoist is a 6-ton CM model the trolley of which travels on an I-beam that has been patched into the original steel work parallel to the axis of the bending rolls.

A smaller set of horizontal pyramid bending rolls is situated near the west end of the south bay. These rolls can handle plates up to 5/8" thick and are 8' in length. The upper roll is approximately 10" in diameter, the lower rolls approximately 9". There is an extra roll on either side of the machine. These rolls are not driven. Rather, they are threaded and bolted into steel channels which are in turn bolted to the cast iron roll housing at the outside of the east housing and the inside of the west housing. Cables are attached to these extra rolls which may function as guides.

The smaller bending rolls are driven from a 15 hp. @ 670 rpm electric motor of undetermined manufacture through speed-reduction mechanisms comparable to the arrangements on the larger rolls. The speed controller in this instance is a Cutler-Hammer Mfg. Co. model. As in the case of the 3" x 11'7" rolls, movement of a clutch engages either the pinion-and-spur gear train to the lower rolls or the shaft and bevel gearing for regulating the position of the upper roll. Plates are handled at the rolls by means of a 2-ton Yale chain hoist. The trolley of this hoist travels on an I-beam which also appears to have been added to the original structure and extends perpendicular to the axis of the bending rolls.

Also located in the south bay are a Model 20AA22 cold saw manufactured by Everett Industries of Warren, Ohio (Serial No.4369), and another metal cut-off saw manufactured by Wallace Speedy Cut of Chicago. On a balcony near the southeast corner of the south bay stand five portable electric arc welding machines made by the Lincoln Electric Company of Cleveland. These models are shielded-arc Type SAE 200 welders capable of generating from 29 to 58 amps at 1500-1800 rpm from 25-cycle current. More modern portable units manufactured by the Miller Welding Company of Appleton, Wisconsin are stationed around the boiler shop floor.

The north bay of the boiler shop presently contains two combination punch and shears. The functions of these machines can be switched from punching holes to cutting metal by changing the type of tooling carried on the sliding head of the machine. Both machines have openings in their frames known as the "throat" the depth of which affects the size of the workpiece that can be accommodated.[4]

Toward the eastern end of the north bay is the Cleveland Punch & Shear Works Model EF with a throat approximately 36" deep. The drive arrangements at the rear of the machine consist of a 7.5hp @ 715 rpm Allis Chalmers motor connected to a short shaft via rubber belting. The diameter of the pulley mounted on this shaft is smaller than the diameter of the pulley on the motor; thus the shaft turns at fewer rpms than the motor. Also keyed on this shaft is a small pinion that meshes into a larger spur gear. The shaft to which the spur gear is connected will therefore revolve more slowly than the shaft carrying the pinion due to the difference in their diameters. A long shaft extends internally through the machine from the pinion to the sliding head. An eccentric on the long shaft converts its rotary motion into the reciprocating stroke of the ram and tool. The ram is counterweighted to improve its action. A flywheel keyed to the short shaft at the opposite end from the pinion stores energy from the motor so that energy is only expended on the working or downward stroke of the sliding head. A jib crane is integral with the machine. The mast of the crane consists of two steel channels riveted back-to-back and mounted atop the machine's frame. A chain hoist trolley travels on the jib.

Near the west end of the north bay stands a second combination punch and shear. This machine was manufactured by the Geo. Whiting Co. of Chicago. The throat is approximately 48" deep. The prime mover for this unit is a 5hp @ 715 rpm General Electric induction motor. Drive arrangement are comparable to those found on the Cleveland punch and shear. On the Whiting machine the pulley on the shaft carrying the pinion is mounted outside the flywheel.

The only other significant piece of equipment in the 1907 boiler shop is the 5' x 15" radial drill. This machine tool is a product of the American Tool Works co. of Cincinnati. It carries an identification or serial number 58747. Power is transmitted from a 15hp, 25-cycle General Electric motor (No.5053153) through rubber belting running in grooved steel pulleys. The radial drill is located on the north side of the main bay toward the west end of the shop.[5]

Significance of Building

The 1907 Oldman Boiler Works shop is a substantially-intact example of a relatively common industrial building type: the high single-story structure with clerestory monitor roof and an interior divided into three parallel longitudinal bays. Structures of this general configuration were initially associated with foundries, forges, rolling mills and other metals industries characterized by thermal processes and the handling of heavy materials. In its overall design and arrangements the Oldman boiler shop also embodies late 19th and early 20th century developments in building materials, construction techniques and power sources. Several scholars have identified the industrial architecture of that period as part of a "new factory system" whose material culture and social relations differed in important details from the initial era of American manufacturing.[6] The shop and its contents are historically significant because of their association with a prominent marine boiler and repair business established in Buffalo at a time when steam propulsion and Great Lakes shipping still played major roles in the local, state and national economies.

The brick and steel Oldman boiler shop shares some obvious features with a much older order of architecture: the Christian basilica with its characteristic central nave flanked by lower, narrower aisles and lit from above through clerestory windows. However, as Matthew Roth has noted in his HAER inventory of Connecticut where single-story industrial plants were common, current functional requirements were more influential than precedents from ecclesiastical architecture in the evolution of this particular building type. Although metalforming and fabricating businesses housed in facilities of this type have been major factors throughout the course of American industrial and labor history, the plants in which their operations were housed have been documented less extensively than other aspects of the built environment such as multi-story textile mills, railroad stations or bridges.[7]

During the antebellum era and the Gilded Age both one-story and multiple-floor industrial buildings shared several constraints on the manner in which they could be constructed. Load-bearing wall technologies, mechanical power transmission systems, relatively permeable roofing materials and limited areas of glazing all conspired to render early factories relatively long but narrow as well as relatively dark.[8] The constant quest for additional space proceeded hand in hand with the search for improved illumination, both natural and artificial.

One strategem for enlarging the window areas in masonry bearing walls involved the use of brick-pier construction. This technique came into vogue as tar paper and other water-repellant roofing materials permitted flatter roof lines and, consequently, wider floors. The method proved suitable for single story plants in addition to the taller and darker Satanic mills; the Civil War-vintage buildings of the Providence Tool Company are an early example of brick-pier construction at a metalworking plant while the Oldman boiler shop stands as a relatively late example.[9] Of course, unlike multi-story mills where considerable ingenuity was expending in modifying roof construction just to light cramped attics or top floors, it was possible to illuminate the work areas of a one-story plant from above as well as through the walls, based, steam-powered transport, naturally gave rise in the early 19th-century to maritime adaptations. The 1807 trials of the *Clermont* on the Hudson River were made with engines and boilers supplied by Bolton & Watt, the company founded in Birmingham, England by Matthew Bolton and James Watt. Over the next five decades, improvements led manufacturers away from the original but highly costly copper boilers to wrought iron boilers then to boilers with steel as the basis for the shell and components.[15]

As materials changed, so did designs, and by the late 19th century, sophisticated boiler construction was well established. The generation of steam power is simple: the boiler turns water to steam which in turn powers the engine that drives the stationary or marine mechanisms. On land or even rail, boilers could vary enormously in size and number, but on sea, ranges in boiler design were far more restricted. These latter boilers had to be adapted to the space and weight limitations of holds on ships. The former problem was more easily solved than the latter, for more compact designs were fairly easily established. The leading developer of marine boiler design was not the Americans or English but the Scots. Boiler manufactories on the River Clyde developed what would become the prevalent design, therefore known as the "Scotch" marine boiler.

The Scotch boiler was a "firetube" boiler in which the internal flues or tubes carried the products of combustion (heat and gas) through the surrounding water contained in the outer shell. Further, since the box-like design of stationary land-use boilers was inadequate aboard cramped ships, this design was replaced with horizontal cylindrical boilers that needed no external bracing. Because of this new form, Scotch boilers were also known as "drum" or "tank" boiler.[16]

The Scotch boiler became the mainstay of the marine trade for nearly a century and survived the encroachments of its rival, the watertube boiler well into the 20th century. The advantages of the watertube boiler lay chiefly in weight; rather than carrying the full water supply in the surrounding shell, watertube boilers consolidated the water supply within the tubes and made the outside shell the environment for combustion. By reducing the overall boiler weight through reducing the amount of water needed to be converted to steam, not only were overall weights diminished but the pressure capacities of the boilers could be increased.[17]

The U.S. Navy pioneered the way for the widescale introduction of watertube boilers with higher pressure capacities. The demands for speed necessarily required a reduction in weight, and, by the 1930s, similar demands for economy were affecting the marine fleets as well. The watertube boiler had key advantages in: concentrated boiling-water capacity; greater structural strength in water tubes than in large water-filled boiler shells; more rapid steaming and therefore more rapid response, and the elimination of numerous repair portholes and the saving of materials and costly designs; greater flexibility in burner industrial architecture as interpreted by a local practitioner working on a shoestring budget.[14] W.H. Zawadzki was predominantly a designer of parochial schools and Polish Catholic churches. Since he did not specialize in industrial designs, his creation in this instance may have reflected the preferences of his clients rather than the specific content of his vision.[15]

Significance of Machinery

The equipment in the 1907 Oldman shop represents a spectrum of boilermaking practice ranging from turn-of-the-century methods through subsequent technological changes in the overall field of steel fabrication. During the early 20th century, the basic steps in boilermaking, particularly with respect to forming the shell plating, were as follows: laying-out, shearing, punching, planing, rolling, drilling, reaming, erecting, caulking, testing. Certain plates were also flanged, a process more akin to blacksmith work, as was dishing the cast iron heads. Depending on the type of boiler, other operations might involve the manufacture or fitting of tubes, flues, fireboxes, staybolts, or other accessories.

In the development of boilermaking as a process and an occupation, most of these steps were initially executed by the workmen's strength of arm and sharpness of eye. The various stages of production were mechanized at an uneven rate during the later 19th century with the appearance of hydraulic and pneumatic riveting equipment, hydraulic flanging presses, and the application of power to other shop tools such as the plate bending rolls. These changes in shop methods were occasioned in part by alterations in boiler specifications and materials. Demands for higher pressures and temperatures to generate steam more efficiently meant that construction techniques had to cope with tougher and thicker metals, thus testing the limits of manual practices.

The technical reorganization of work and reconstitution of skill in boiler shops around the turn of the century paralleled comparable developments in other branches of the metal trades such as machine shops and foundries. New conditions on the shop floor were accompanied by efforts to implement new strategies of scientific or systematic management while abolishing the influence of trade unions. Both ideologies were rhetorical staples of the majority of American manufacturers during the open-shop era whose conflicts mark an important chapter in labor history.[16]

Finally, the nature of equipment and work in the fields of boilermaking and plate fabrication shifted once again with the gradual introduction of welding. Electric arc welding as well as gas torch cutting and welding procedures eventually displaced pneumatic and hydraulic riveting from most of their previous applications along with other tools and techniques that were once mainstays of boiler shop practice. However, the encroachment of welding was incremental and the newer processes were not approved for marine pressure vessels until the 1930s.

Extant equipment in the 1907 Oldman shop illustrate some but not all of the fabricating techniques that prevailed at the time the building was erected. The type and number of tools used at the outset of the firm's initial expansion remain undetermined. As of 1922 an inventory of Oldman Boiler Work's fixed assets indicates that the following major machines were present:

2 Cleveland punches (36")
2 horizontal punches
1 bevel shear
1 upright drill, large
1 upright drill, small
1 McCabe flanger
1 set 8"[sic] bending rolls
1 electric welding plant.

The plate rolls at that time were still powered by steam, using one of the two upright boilers inventoried; no engine was identified. All the other equipment was presumably drive by electric motors, though it is not possible to determine with any precision whether individual or group drive was used. There were at least five air compressors on the property, suggesting that pneumatic riveting was employed to a considerable extent.[17]

As of 1947 equipment in the Oldman boiler shop that had been in use as of 1922 included the two Cleveland punch and shears, the 8' plate bending rolls, and the McCabe flanger. Additions during the interim consisted of: the 3' x 11'7" plate rolls; two radial drills (presumably to replace the upright drills); a combination punch and shear by Hilles & Jones Company of Wilmington, Delaware; a universal iron workers by the Buffalo Forge Company that also combined punching, plate shearing, and bar cutting functions; an emery wheel grinder, and another portable arc welder. At the same time Oldman also possessed machinery located at the adjacent property on Indiana Street, the former Phoenix Boiler Works. These tools included a set of angle rolls and a Whiting shear. By 1950, the rim had purchased the American Tool Works Company's 5' x 15" radial drill and may have acquired a second Buffalo Forge Company iron worker as well.[18]

The sequence of documentary sources thus suggests that among the present shop equipment the tools with the longest tenure are the Cleveland punch and shear and the 5/8' x 8' plate bending rolls. The Whiting shear and the large plate tolls appear to posses comparable features. These four machines are most likely to provide insights into the design and operation of early 20th century boilermaking tools, thus illustrating two of the key stages in the overall production process.

The two sets of plate rolls are particularly interesting since they were operated primarily by "feel" and experience. Neither has any pressure gauges. The top roll must be adjusted to the proper height for rolling a plate into a circle of any given diameter by estimation. The shop rule of thumb is that a movement of one tooth on the bevel gearing (raising or lowering the roller) will alter the diameter of the circular plate by one inch.[19] Early pyramid bending rolls were likely to be powered by hand via capstan rolls, one attached to the lower rollers and the other to the top roller.[20] The late Victorian boilermaking industry of Buffalo was also the birthplace of what reputedly was the first set of large rolls to be built in the U.S. (rather than being imported from Great Britain) that was designed to be driven by a separate prime mover, namely the 18' bending rolls at the Lake Erie Boiler Works that commenced operation in 1882 and that were still active in 1906. This advanced machine was designed and built by Lake Erie owner, Richard Hammond, whose plant was also the first in the U.S. to use hydraulic machinery in the construction of marine boilers. [21] Thus, Buffalo-based developments would have been readily accessible to the Oldmans when their business began in earnest.

NOTES

1. Permit #24191, April 9, 1907, Plans and Permits, Buffalo City Hall (hereafter cited BCH). Original plans, consist of four sheets of drawings and one sheet of specifications. They apparently are no longer extant. The estimated cost of construction in 1907 was $9000.

2. Oldman Boiler Works, Blueprint drawing No. 186-B, "Building #1," (October 6, 1947) Oldman Boiler Works Papers, Buffalo and Erie County Historical Society (hereafter cited BECHS).

3. On the general design features of early 20th-century plate rolls see: "Cincinnati Bending Rolls," *The Boiler Maker* 5/6 (June, 1905): 181-82; "The Bertsch Improved Bending Rolls," *The Boiler Maker* 7/6 (June, 1907):188; "Bending Rolls," *The Boiler Maker* 8/8 (August, 1908): 273; "Large Bending Rolls," *The Boiler Maker* 18/7 (July, 1918): 204; "Direct-Connected Motor-Driven Bending Rolls," *The Boiler Maker* 23/6 (June, 1923): 181; "Plate Bending Roll for Heine Boiler Shop," *The Boiler Maker* 23/11 (November, 1923): 320-21; "Pyramid-Type Bending Roll," *The Boiler Maker* 31/8 (August, 1931: 210.

4. On the general design features of early 20th-century combination punch and shears see: "New Doty Punch and Shear," *The Boiler Maker* 6/2 (February, 1906):54; "A Large Punch," *The Boiler Maker* 6/6 (June, 1906): 177; "McCabe Punches and Shears," *The Boiler Maker* 6/9 (September, 1906): 268; "A Boiler Maker's Utility Punch," *The Boiler Maker* 12/1 (January, 1912): 29-30; "Covington Punches," *The Boiler Maker* 16/2 (February, 1916): 51

5. On the general design features of radial drills from the inter-war years, see: "High Power Radial Drilling Machine," *The Boiler Maker* 20/4 (April, 1920): 111; "Ball Bearing Heavy Duty Radial Drill," *The Boiler Maker* 25/4 (April, 1925): 111; "The Cincinnati Bickford New Radial Drill," *The Boiler Maker* 26/11 (November, 1926): 326-28; "Multiple-Spindle Drill Heads Used on Radial Drills," *The Boiler Maker and Plate Fabricator* 34/12 (December, 1934): 332; "Triple Purpose Radial Drill," *Boiler Maker and Plate Fabricator* 35/8 (August, 1935): 219.

6. Daniel Nelson. *Managers and Workers: Origins of the New Factory System in the United States, 1880-1920* (Madison: University of Wisconsin Press, 1975): 11-25.

7. Matthew Roth et al., *Connecticut: An Inventory of Historic Engineering and Industrial Sites* (Washington, D.C.: Society for Industrial Archeology, 1981),xxiii-xxiv.

8. On the development of textile mill architecture in general and the antebellum period in particular, see Gary Kulik and Julia C. Bonham, *Rhode Island: An Inventory of Historic Engineering and Industrial Sites* (Washington, D.C.: U.S. Government Printing Office, 1978), 7, 8, 18-19, 22; William H. Pierson, Jr., *American Buildings and Their Architects: Technology and the Picturesque -The Corporate and Early Gothic Styles* (Garden City, NY: Doubleday & Company, Inc., 1978), 28-90.

9. Kulik and Bonham, *Rhode Island*, 195, 197-98.

10. For a description of a boiler plant designed on the three-bay plan and dating to 1882 see "The Lake Erie Boiler Works, Buffalo, N.Y.," *The Boiler Maker* 6/10 (October, 1906): 271-75. See also H.C. Meinholtz, "Modern Boiler Shops and How Same Should Be Equipped," *The Boiler Maker* 12/5 (May, 1912): 151-52.

11. On the mixture of single-story and multi-story buildings at early automobile manufacturing complexes see David A. Hounshell, *From the American System to Mass Production, 1800-1932: The Development of Manufacturing Technology in the United States* (Baltimore: Johns Hopkins University Press, 1984), 226-27 and Reyner Banham, *A Concrete Atlantis: U.S. Industrial Building and European Modern Architecture, 1900-1925* (Cambridge, MA: MIT Press, 1986), 86-88, 97-101.

12 For examples of early 20th-century boiler shops built on the three bay plan see "Boiler Shops of Goldie & McCulloch Company, Ld.," *The Boiler Maker* 5/9 (September, 1905): 266-69; "Boiler Shop of the Thomas C. Basshor Company," *The Boiler Maker* 8/2 (February, 1908): 33-35; "A Repair Shop," *The Boiler Maker* 8/5 (May. 1908): 150-51; "Marine Boiler Shop on the Great Lakes," *The Boiler Maker* 19/4 (April, 1919): 91-92; C.B. Lindstrom, "Plant of the Duluth Boiler Works," *The Boiler Maker* 19/12 (December, 1919): 347-50; "Quantity Production of Scotch Marine Boilers," *The Boiler Maker* 21/3 (March, 1921): 63-69.

13. On the application of electric power to boiler shop machinery see "Individual Electric Motor Drive in Boiler Shops," *The Boiler Maker* 9/11 (November, 1909): 301-03; D.S. Downs, "The Powering of Boiler Shops," *The Boiler Maker* 10/3 (March, 1910): 65-68; "Electric Drive in the Boiler Shop," *The Boiler Maker* 10/3 (March, 1910): 84; J.E. Bullard, "Electric Drive for the Boiler Shop," *The Boiler Maker* 15/2 (February, 1915): 61-62.

14. "The Use of Electric Cranes and Hoists in Boiler Shops," *The Boiler Maker* 6/3 (March, 1906): 82-83.

15. On technological change in boilermaking methods around the time the 1907 Oldman boiler shop was built see William O. Webber, "Modern Boiler Making," *Cassier's Magazine* 7/5 (March, 1895): 397-409; H. C. Meinholtz, "The Modern Boiler Shop and Its Equipment," *Iron Trade Review* 50/20 (May 16, 1912): 1061-62; C.A. Tupper, "Progress in Boiler, Tank and Plate Shops," *Iron Age* 92/26 (December 25, 1913): 1427-30; E. C. Meier, "Equipment, Processes and Methods for the Boiler Shop," *Transactions of the International Engineering Congress, 1915* (San Francisco: Neal Publishing Company, 1916), 6: 375-90. Obituary, Wladyslaw Zawadzki, *Buffalo Morning Express*, January 18, 1926, p. 5; *Buffalo Courier*, January 18, 1926, p.14.

16. On labor-management conflict in the metal trades during the late 19th and early 20th centuries see Nelson, *Managers and Workers* and David Montgomery, *The Fall of the House of Labor: The Workplace, The State, and American Labor Activism, 1865-1925* (Cambridge: Cambridge University Press, 1987): 171-213.

17. William J. Gunnell to Oldman Boiler Works, "Oldman Boiler Works Fixed Assets and Marine Welding Co. Fixed Assets," October 28, 1922, Oldman Boiler Works Papers, BECHS.

18 Drawing Nos. 186-B, "Building #1" (October 6, 1947), No. 183-B, "Building #2 and Yard" (October 6, 1947). 500-B, "Plant Layout" (May 9, 1950), Oldman Boiler Works Papers, BECHS.

19. Interview with Paul Keefe, Shop Supervisor, Oldman Boiler Works, June 29, 1994.

20. William F. Campbell, "Boiler Making in the Old Days," *Boiler Maker and Plate Fabricator* 35/9 (September, 1935): 243.

21. "Lake Erie Boiler Works:" 272-73; Richard Edwards, *New York's Great Industries: Buffalo and Its Vicinity, 1884-1885* (New York: Historical Publishing Co., 1884), 87; *A History of the City of Buffalo* (Buffalo: Buffalo Evening News, 1908), 93.

BIBLIOGRAPHY

Documentary sources on Oldman Boiler Works and related companies is in the Oldman Boiler Works Papers, Buffalo and Erie County Historical Society.

"Ball Bearing Heavy Duty Radial Drill," *The Boiler Maker* 25/4 (April, 1925): 111.

Banham, Reyner. *A Concrete Atlantis: U.S. Industrial Building and European Modern Architecture, 1900-1925* Cambridge, MA: MIT Press, 1986.

"Bending Rolls," *The Boiler Maker* 8/8/ (August 8, 1908): 273.

"A Boiler Maker's Utility Punch," *The Boiler Maker* 12/1 (January, 1912): 29-30.

"Boiler Shop of the Thomas C. Basshor Company," *The Boiler Maker* 8/2 (February, 1908): 33-35.

"Boiler Shops of Goldie & McCulloch Company, Ld," *The Boiler Maker* 5/9 (September, 1905): 266-69.

"The Bertsch Improved Bending Rolls," *The Boiler Maker* 7/6 (June, 1907): 188.

Bullard, J.E. "Electric Drive for the Boiler Shop," *The Boiler Maker* 15/2 (February, 1915): 61-62.

Campbell, William F. "Boiler Making in the Old Days," *The Boiler Maker and Plate Fabricator* 35/9 (September, 1935): 243-44.

"Cincinnati Bending Rolls," *The Boiler Maker* 5/6 (June, 1905): 181-82.

"The Cincinnati Bickford New Radial Drill," *The Boiler Maker* 26/11 (November, 1926): 326-28.

"Covington Punches," *The Boiler Maker* 16/2 (February, 1916): 51.

"Direct-Connected Motor-Driven Bending Rolls," *The Boiler Maker* 23/6 (June, 1923): 181.

Downs, D.S. "The Powering of Boiler Shops," *The Boiler Maker* 10/3 (March, 1910): 65-68.

Edwards, Richard. *New York's Great Industries: Buffalo and Its Vicinity, 1884-1885.* New York" Historical Publishing Co., 1884.

"Electric Drive in the Boiler Shop," *The Boiler Maker* 10/3 (March, 1910): 84.

"High Power Radial Drilling Machine," *The Boiler Maker* 20/4 (April, 1920): 111.

A History of the City of Buffalo. Buffalo: Buffalo Evening News, 1908.

Hounshell, David A. *From the American System to Mass Production, 1800-1932: The Development of Manufacturing Technology in the United States.* Baltimore: Johns Hopkins University Press, 1984.

"Individual Electric Motor Drive in Boiler Shops," *The Boiler Maker* 9/11 (November, 1909): 301-03.

Kulik, Gary and Julia C. Bonham. *Rhode Island: An Inventory of Historic Engineering and Industrial Sites.* Washington, D.C.: U.S. Government Printing Office, 1978.

"The Lake Erie Boiler Works, Buffalo, N.Y.," *The Boiler Maker* 6/10 (October, 1906): 271-75.

"Large Bending Rolls," *The Boiler Maker* 18/7 (July, 1918): 204.

"A Large Punch," *The Boiler Maker* 6/6 (June, 1906): 177.

Lindstrom, C.B. "Plant of the Duluth Boiler Works," *The Boiler Maker* 19/12 (December, 1919): 347-50.

"Marine Boiler Shop on the Great Lakes," *The Boiler Maker* 19/4 (April, 1919): 91-92.

"McCabe Punches and Shears," *The Boiler Maker* 6/9 (September, 1906): 268.

Meier, E.C. "Equipment, Processes and Methods for the Boiler Shop," *Transactions of the International Engineering Congress 1915.* San Francisco: Neal Publishing Company, 1916.

Meinholtz, H.C. "The Modern Boiler Shop and Its Equipment," *Iron Trade Review* 50/20 (May 16, 1912): 1061-62.

________________ "Modern Boiler Shops and How Same Should Be Equipped," *The Boiler Maker* 12/5 (May, 1912): 151-52.

Montgomery, David. *The Fall of the House of Labor: The Workplace, The State, and American Labor Activism, 1865-1925.* Cambridge: Cambridge University Press, 1987.

"Multiple-Spindle Drill Heads Used on Radial Drills," *The Boiler Maker and Plate Fabricator* 34/12 (December, 1934): 332.

Nelson, Daniel. *Managers and Workers: Origins of the New Factory System in the United States, 1880-1925.* Madison: University of Wisconsin Press, 1975.

"New Doty Punch and Shear," *The Boiler Maker* 6/2 (February, 1906): 54.

Pierson, William H., Jr. *American Buildings and Their Architects: Technology and the Picturesque - The Corporate and Early Gothic Styles.* Garden City, NY: Doubleday & Company, 1978.

"Plate Bending Rolls for Heine Boiler Shop," *The Boiler Maker* 23/11 (November, 1923): 320-21.

"Pyramid-Type Bending Roll," *The Boiler Maker* 31/8 (August, 1931): 210.

"Quantity Production of Scotch Marine Boilers," *The Boiler Maker* 21/3 (March, 1921): 63-69.

"A Repair Shop," *The Boiler Maker* 8/5 (May, 1908): 150-51.

Roth, Matthew et al. *Connecticut: An Inventory of Historic Engineering and Industrial Sites.* Washington, D.C.: Society for Industrial Archeology, 1981.

"Triple Purpose Radial Drill," *The Boiler Maker and Plate Fabricator* 35/8 (August, 1935): 219.

Tupper, C.A. "Progress in Boiler, Tank and Plate Shops," *Iron Age* 92/26 (December 25, 1913): 1427-30.

"The Use of Electric Cranes and Hoists in Boiler Shops," *The Boiler Maker* 6/3 (March, 1906): 82-83.

Webber, William O. "Modern Boiler Making," *Cassier's Magazine* 7/5 (March, 1895): 397-409.